## ABSTRACT

[0074] A pinned photodiode with an ultra-shallow highly-doped surface layer of a first conductivity type and a method of formation are disclosed. The ultra-shallow highly-doped surface layer has a thickness of about 100 Angstroms to about 500 Angstroms and a dopant concentration of about $5 \times 10^{17}$ atoms per $cm^3$ to about $1 \times 10^{19}$ atoms per $cm^3$. The ultra-shallow highly-doped surface layer is formed by diffusion of ions from a doped layer into the substrate or by a plasma doping process. The ultra-shallow pinned layer is in contact with a charge collection region of a second conductivity type.